The Behaviour of the Lesser Bandicoot Rat, *Bandicota bengalensis* (Gray & Hardwicke)

BY

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(With eleven text-figures)

A study of the behaviour of 4 adult Lesser Bandicoot Rats, *Bandicota bengalensis*, was conducted by observing their activity for 50 minutes per hour, 24 hours per day for 28 days. The animals were studied in a pen in which they could burrow freely. The amount of food removed from the food containers was measured and the amount of food hoarded was calculated. Measurements were also made of the amount of time spent above ground, the number of trips to the food platform, the timing of activity, and the number and types of social interactions.

INTRODUCTION

The lesser bandicoot rat, *Bandicota bengalensis*, is distributed throughout most of India, East Pakistan, and parts of Burma (Biswas & Tiwari; in press) and occupies both rural and urban environments. In rural areas it is an agricultural pest, burrowing into bunds separating farm plots and attacking standing crops. In cities this animal destroys large amounts of stored food and seems to be replacing *Rattus rattus* as the main urban rat. Records from the Plague Control Laboratory in Calcutta show that between 1936 and 1965, *B. bengalensis* increased from about 27 per cent to about 90 per cent of the rats captured in Calcutta and Howrah (Seal & Banerji; in press). This displacement of *R. rattus* represents a potential health hazard, as *B. bengalensis* has been reported to be more susceptible to the plague bacillus than *R. rattus* (Nimbkar & Deoras; in press).

The success of this species in replacing *R. rattus* is coupled with its high reproductive capacity. Southwick (in press) has compared the reproductive patterns of several murid rodents and using Spillett's study of the bandicoots of warehouses in Calcutta and Howrah, showed an annual production of 69.6 young per year per female in *B. bengalensis*, as compared with 35.7 for *R. norvegicus* and 31.3 for *R. rattus*. Spillett (1968) in his warehouse studies found that the average population density for all 12 months of the year was .77 rats/square metre of warehouse floor space. However, the captures greatly decreased during the rainy months of July and August and when these two months are excluded, the average density jumps to 8.5 rats/square metre of floor space (personal communication).

There are few estimates of the amount of food lost to this bandicoot; Deoras (1966) and Spillett (1968) reported on the daily consumption of caged animals. Patnaik (in press) has reviewed the estimates of daily consumptions for Indian rats in general and reports estimates of 20, 25, 30 and 60 g./day, but it is not possible to know if any of these figures are for *B. bengalensis*, or if they represent hoarding as well as actual consumption. Pingale *et al.* have gathered somewhat more detailed information for several species of murid rodents.

Little is known of the behaviour of this species. Deoras (1967) has gathered information about their burrows, and Parrack (1966) reported on the activity cycle of animals in activity cages, but almost nothing is known of other aspects of the behaviour of this animal.

As Kavanau (1967) and others have pointed out, the relatively sterile environment to which captive animals are often submitted tends to distort their behaviour. Zoo animals, for instance, often develop highly stereotyped behaviour which is completely foreign to their behaviour in the wild. To avoid the distortion of the behaviour of the bandicoots used in these studies, we have used a pen which, because of its dirt floor, allows for burrowing (apparently a strong psychological "need" in these animals) and which allows considerable freedom for running about. Six groups of bandicoots, usually 4 adults (2 males and 2 females) have been studied. The number of periods of observation (50 minutes) varied from 6 to 24 in a 24 hour period. The present study, using 24 periods/day, is intended as a base-line for other studies.

Materials and Methods

Two adult males (No. 33, weighing 245.8 gm.; No. 34, 211.4 gm.) and two adult females (No. 35, 190.0 gm.; No. 36, 165.5 gm.) were used in this study. All 4 animals had been trapped in a grain warehouse in Calcutta and housed in individual cages for 3 days before the study began. The animals were individually marked by clipping the hair in different parts of the body. All were apparently healthy and neither of the females showed signs of pregnancy. The animals were introduced into the study pen simultaneously in order to avoid the effects of prior occupancy. Detailed recording of the behaviour was begun at 17.00 hours, a few hours after introduction.

The pen was constructed of bricks, mortar, and plaster and measured 4 by 6 m. (fig. 1). The walls were sunk 2 feet beneath the surface of the surrounding ground and 3 feet of additional dirt was put into the pen, thus reducing the chances of the animals digging out. The floor of the pen was laid off in 24, 1-metre squares with rows of half-buried bricks. and the squares were identified by combinations of letters and numbers,

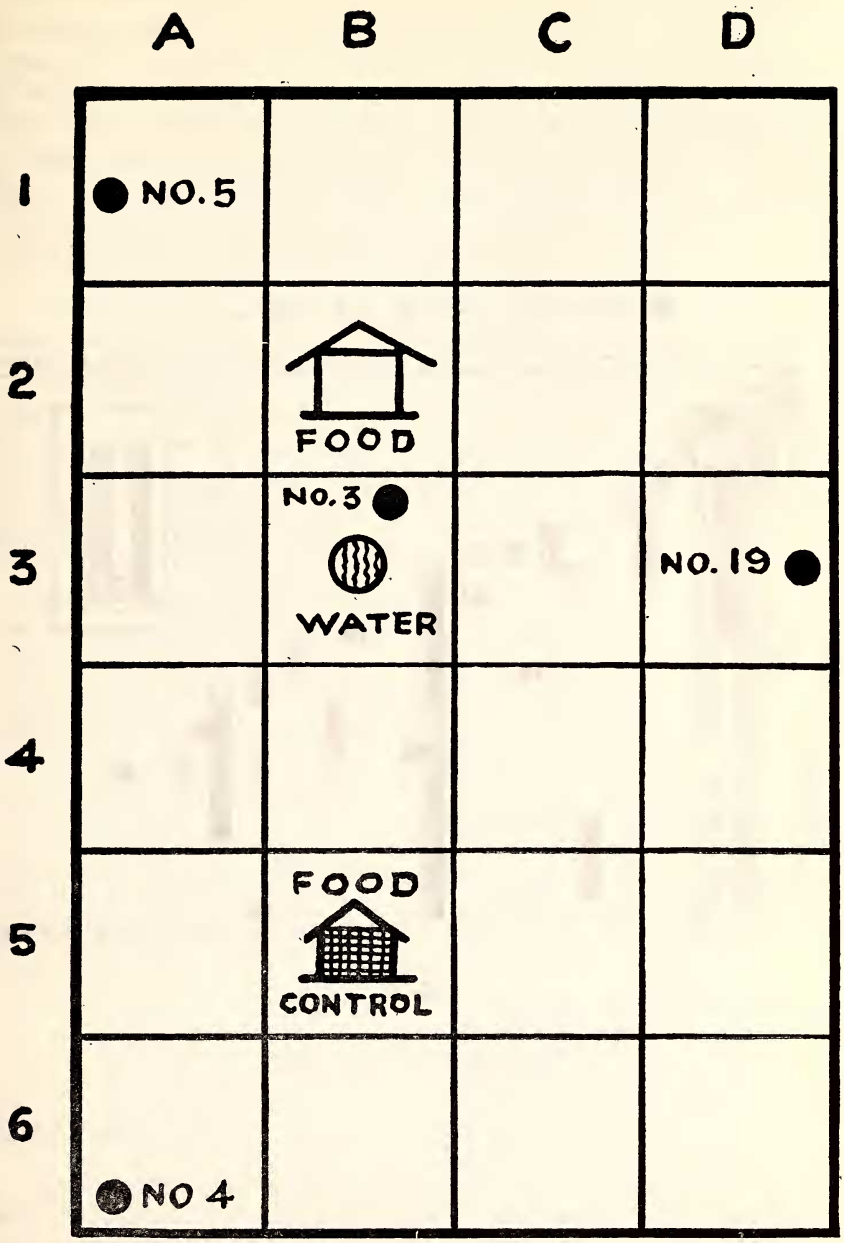


Fig. 1.

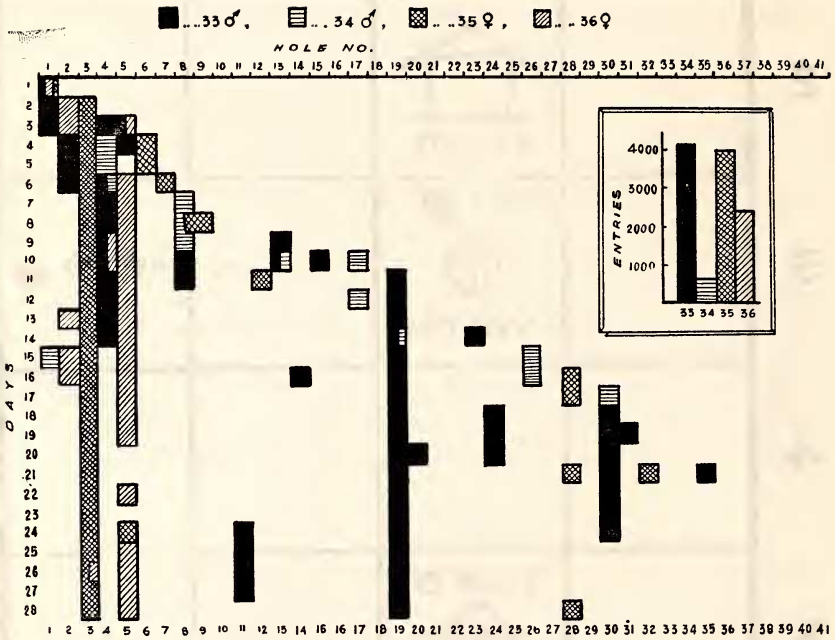


Fig. 2

The pen was roofed with wire mesh to prevent the entry of birds and predators. At night the pen was lighted with 4, 60-watt, clear light bulbs. A covered feeding platform was placed in square B-2 which had been bricked-in to prevent holes being dug directly beneath the platform. A large mirror was hung on the wall behind the feeding platform so that the observers could see the animals which were hidden by the platform. A water dish was placed in square B-3 and in square B-4 there were caged food dishes (inaccessible to the rats) which were used as controls for changes in the weight of food due to relative humidity. Each burrow was marked with a stake bearing a number.

Supplies of rice, wheat, and dal (*Lens culinaris*) were put into the food dishes and weighed at 17.00 hours and at 06.00 hours each day.

The observational " day " began at 18.00 hours and ended 24 hours later. In the present study observations were made 50 minutes/hour, 24 hours/day for 28 days. The study was conducted during the winter (13 January to 10 February, 1968) during which time there was almost no rain and the average daily maximum and minimum temperatures were 78.8°F and 58.0°F respectively.

Observations were made from a shed at one end of the pen, one observer recording the activity of one male and one female, a second observer recording the behaviour of the other 2 animals. The observers " traded " rats several times per day and the working hours of the observers were shifted to prevent individual bias in recording.

Collective food consumption was recorded twice per day and the following data were recorded for each rat: number of squares entered, number of trips to food and water, number of entries into and exits from each burrow, time above ground, time spent in digging and grooming, and the number and type of social interactions. The data were transferred to punched cards and tabulated on an IBM 407 tabulator.

Results and Discussion

Social Rank

In this study, as well as in others yet to be completely analysed, the animals began a series of fights within 5 minutes after being introduced into the pen. The fighting often was associated with the digging of holes. One animal would begin digging only to have another attempt to displace him, or her, from the hole. Within 15 or 20 minutes the dominant animal was identifiable by the observers because of his aggressiveness and the number of times the others moved away from him.

The larger male, No. 33, very quickly established himself as the dominant and the smaller male, No. 34, was clearly the subordinate. Aspects of the dominance and subordinance of the males will be considered later. It is difficult to assign a rank to the females, as they had much less social interaction than male. The fact that 35 ♀ outweighed 36 ♀ by almost 25 g. suggests that she had a physical advantage over the latter. Further, she occupied the most favourable hole (under the food platform) and visited the food more often than did 36 ♀. Also, she was much more inclined to fight, initiating some 15 fights (as compared to 17 initiated by 33♂ and 1 by 36). Her weight, the location of her burrow, the number of her visits to food, and her aggressiveness might be indications that she out-ranked the other female.

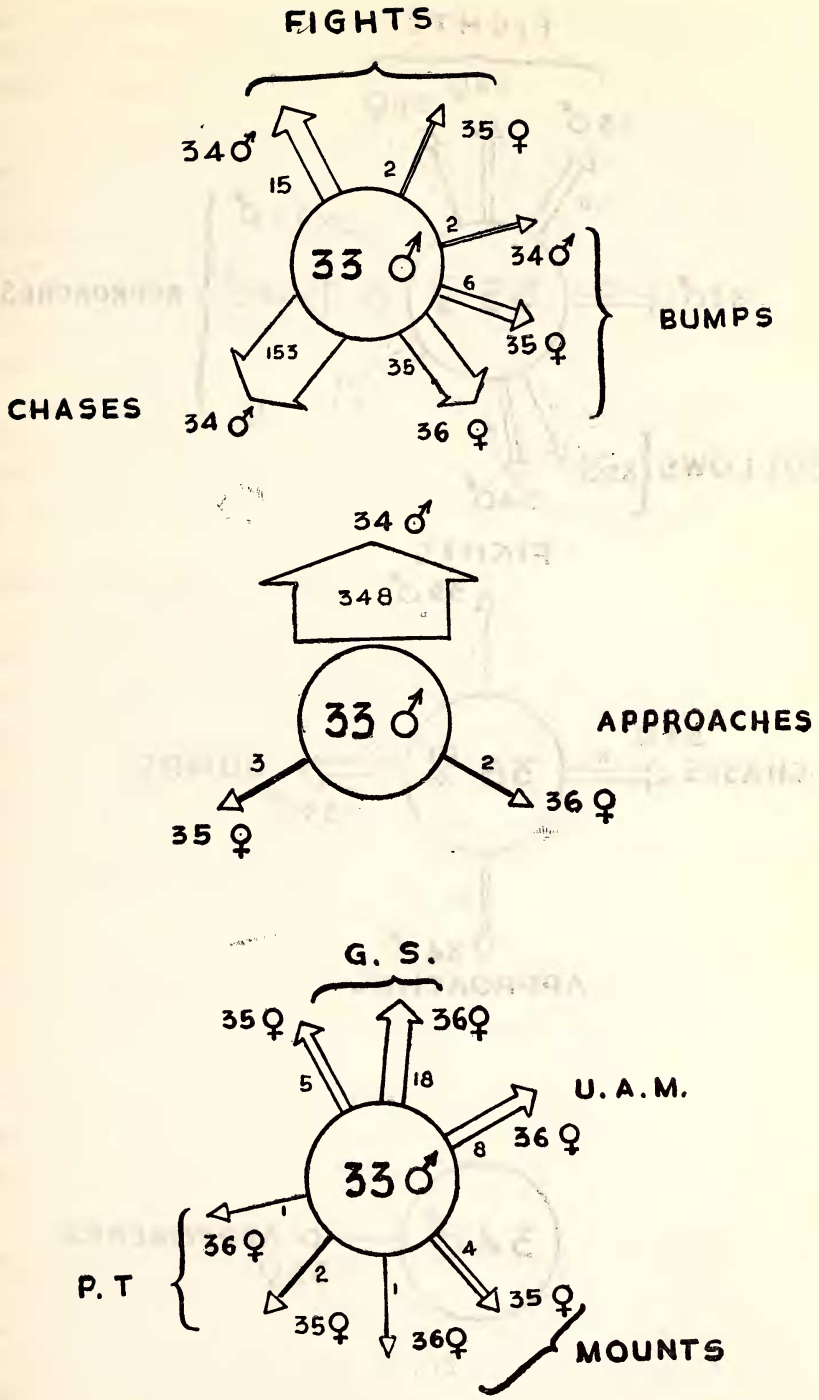
Barnett (1958) distinguished three ranks of males in laboratory colonies of wild *Rattus norvegicus:* (1) "alpha" males, which were larger than the others, were aggressive, displayed no hesitation in moving in the cage, and always gained weight; (2) "beta" males, which ranked below the "alpha" but above the "omegas," had been defeated by the "alphas" in combat but did not develop "shock" and always gained weight; (3) "omega" males, which were continuously persecuted, moved about more slowly, had poor condition of the fur, lost weight, and often died of "shock."

In the present study the two males showed mixtures of characteristics of all three ranks. The dominant male (33) was like Barnett's "alphas" in that he was larger, more aggressive, and moved freely about the pen. However, he lost weight (20.3 gm.). The subordinate male (34) resembled Barnett's "omegas" in being continuously harassed by the dominant, moving more slowly (Table 2) and in losing weight (15.4 gm.). However, the fact that he survived the 28 days of persecution would seem to classify him as a "beta".

Food Consumption

The animals used in this study almost always emptied the food dishes after each of the two daily fillings. The food supply, therefore, was not unlimited, but it was more than adequate, since excavation of the burrows at the end of the study revealed a considerable amount of rotting food. During the 28 days of the study, a total of 4,398 gm. of food was removed, a daily average of 162.9 gm. of 40.7/gm./rat/day. These figures lie somewhere between the minimal requirements and the amount they would remove given an unlimited supply.

Grain warehouses often have, what to the rats, are limitless supplies of food. In a study of 8 penned bandicoots Parrack (in press) found


FIGHTS
34♂
35♀
15
2
2
33♂
34♂
6
BUMPS
35♀
153
35
CHASES
34♂
36♀
34♂
348
33♂
APPROACHES
3
2
35♀
36♀
G. S.
35♀
36♀
5
18
U.A.M.
8
36♀
33♂
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36♀
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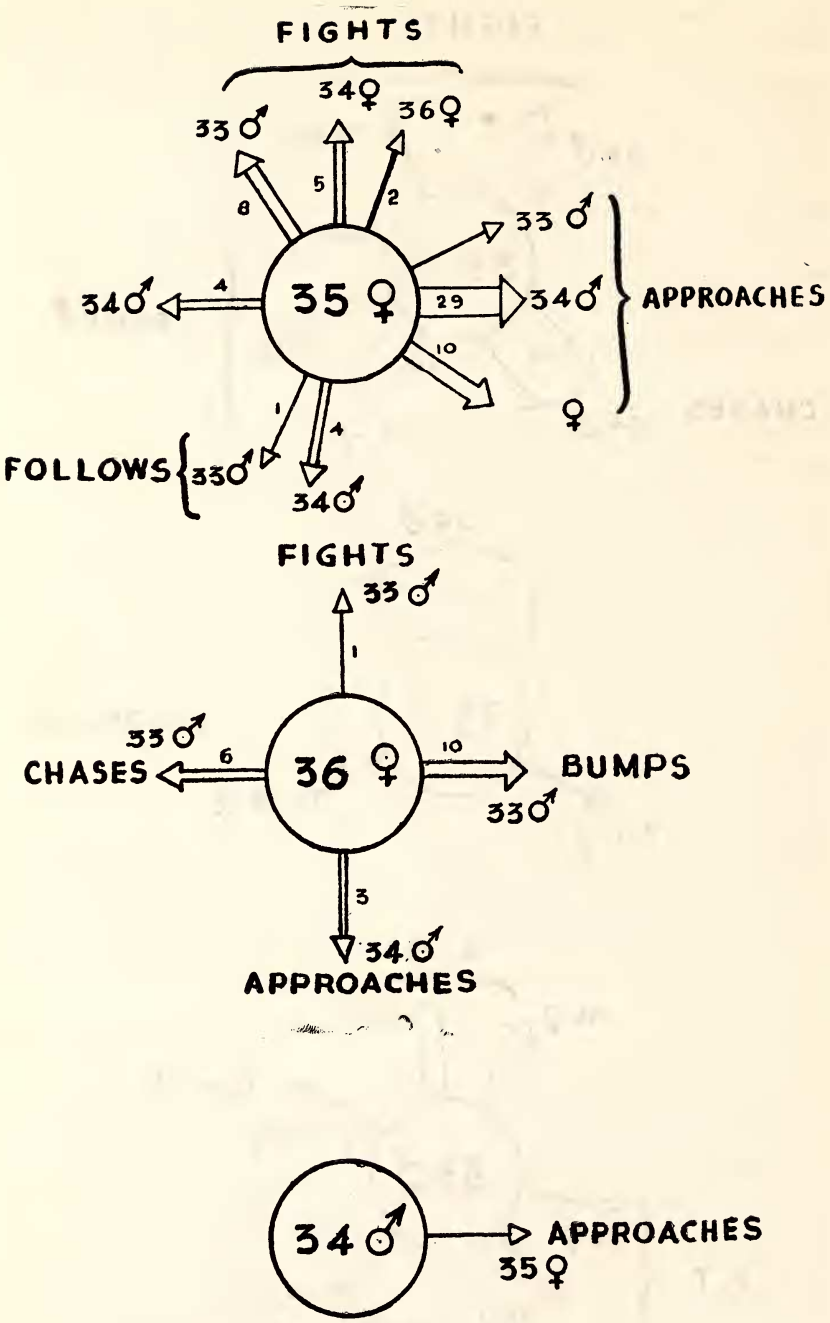
36♀
MOUNTS

Fig. 3.


FIGHTS
34♀
36♀
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8
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APPROACHES
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♀
1
4
FOLLOWS
33♂
34♂
FIGHTS
33♂
1
33♂
CHASES
6
36♀
10
BUMPS
33♂
3
34♂
APPROACHES
34♂
APPROACHES
35♀

Fig. 4

that given an unlimited supply the rats removed a daily average of 67.4 gm./rat and calculated that this amount was about 5 times the amount actually consumed.

Deoras (1967) reported a daily consumption of 12.8 gm./rat/day and Spillett (1968) reported about 11 gm./rat/day. These figures are for the amount actually eaten and do not include hoarding. Our own studies (in press) of adults in individual cages which allowed no hoarding showed an average consumption of 14.9 gm./rat/day (34 rats; $\bar{x}$ body wt. =216.7 gm.). The discrepancies in these three reports are probably due to individual variations in the physiology of the rats, the body size of the rats, the season of the year, and the duration of captivity.

If the average of the three reports (12.9 gm. rat/day) is taken to be fairly reliable estimate of actual food consumption, the animals in the present study were probably consuming 32 per cent and hoarding 68 per cent of the total amount removed from the food containers.

General Comparison of Individuals

During the course of the study the males lost weight and the females gained. Table 2 summarizes several types of activity for the entire study period. In most of these activities there is a strong difference between the sexes. In terms of the total number of squares entered, the males were much more active than the females, with the dominant male (No. 33) entering almost 7 times as many squares as the least active female. The number of squares entered is also associated with the initial weight of the animals, the heaviest animal (33♂) being the most active, the lightest (36♀), the least active.

TABLE 1

CHANGES IN BODY WEIGHT DURING THE 28 DAYS OF THE STUDY

Rat No.	Initial wt. (gm.)	Final wt. (gm.)	Change (gm.)
33♂	245.8	225.5	— 20.3
34♂	211.4	196.0	— 15.4
35♀	190.0	229.5	+ 39.5
36♀	165.5	195.3	+ 29.8
Overall average body wt.=207.4 gm.			

The subordinate male spent more than twice as much time above ground than did the dominant male. It seems likely that he was prevented from entering the burrows by the dominant. Not only did the subordinate

male spend more time above ground, he moved about less rapidly than the other 3 animals, entering only 1.7 squares/minute above ground, as compared with 5.4 for the dominant and 7.6 for 35 ♀. Female 35 and the dominant male made frequent trips to the food platform (both more than 3000 times), while 34 ♂ and 36 ♀ went much less often. The subordinate male did much more wandering per trip to food (21.6 squares/trip) than did the others. The 2 females had taken up residence in burrows near the food platform and confined most of their movement to food gathering, hence they entered only 2.2 (35 ♀) and 3.1 (36 ♀) squares per trip. Female 35, who occupied a hole under the food platform, visited the food dishes on an average of every 17 seconds (.3 min./trip) when she was above ground, while female 36, occupying a hole slightly further away, returned to the platform every 38 seconds (.6 min./trip). The subordinate male returned to platform on an average of every 12.5 minutes in contrast to the dominant male who returned after average intervalsof 1.6 minutes.

Grooming : Neither of the females was observed grooming. Male 33 groomed for a total of 9 minutes and male 34 for 20 minutes. Grooming as a displacement activity has been reported for several rodents and Barnett (1958) describes it in *R. rattus*. Displacement activities occur when the expression of a drive is blocked or frustrated. That the males, rather than the females, groomed in this study and that the subordinate male groomed much more than the dominant, suggests that at least some of the grooming observed here was a displacement.

Digging : The amount of time of observed digging was not related to sex or rank. It is known that most, if not all, of the burrows were interconnected, and as the burrows were extensive, much of the digging must have been done when the animals were invisible to the observers.

Trips to water : The timing of the trips to the water container reflected the general pattern of activity, that is, during those hours when the animals entered many squares, there was an increase in the number of trips to water. Most of the trips fell between 18.00-24.00 hours and 06.00-09.00 hours, the times in which the food platform was visited more frequently. There was, however, no correlation between the daily total of squares entered and the daily total of trips to water.

Diurnal activity : Although bandicoots are generally nocturnal, they, like *R. norvegicus* (Calhoun 1962), will become active during the day time under undisturbed conditions. Of the total time spent above ground by all 4 animals about 35 per cent was during the day time and about 48 per cent of the trips to the food platform took place during the day-light hours.

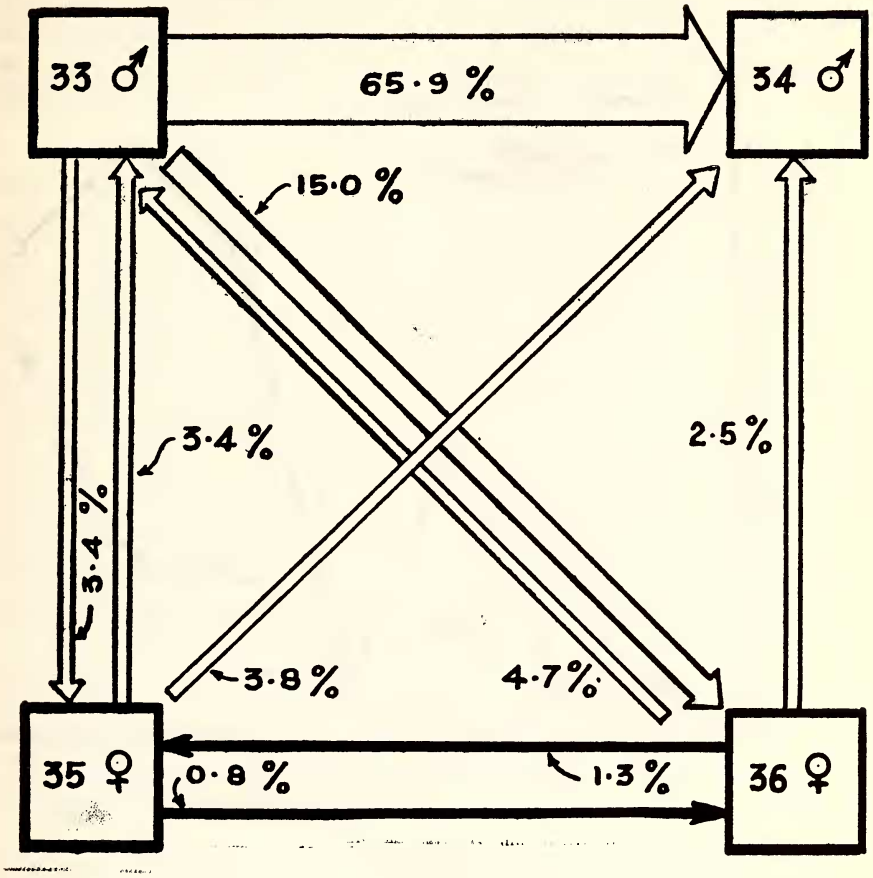

Fig. 5

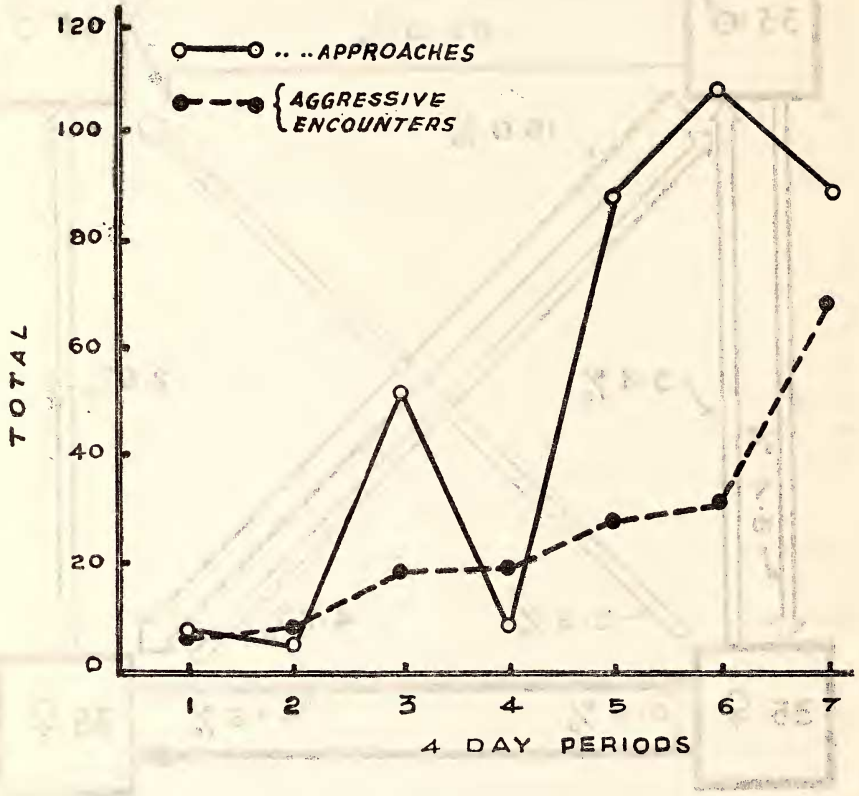
120
100
80
60
40
20
0
TOTAL
.. .. APPROACHES
AGGRESSIVE ENCOUNTERS
1
2
3
4
5
6
7
4 DAY PERIODS

Fig. 6

Use of Burrows

Forty-one holes were dug by the rats during the 28 days of the study. The usage of these holes (as indicated by the number of times the animals entered or left them) was far from uniform. No entries were recorded for 2 of the holes after they had been dug. On the other hand, some of the holes were entered well over a thousand times. Fig. 2 gives a history of the occupancy of the holes which has been simplified by considering only those holes which were entered 10 or more times in a day by an individual rat. The records of entries and exits were so nearly identical that only the entries will be considered.

The most striking characteristic illustrated by fig. 2 is that the females tend to settle down very quickly to occupying one hole, while the males are more inclined to change burrows. On day 2, female 35 began frequenting hole No. 3 (under the food platform, fig. 1) which she occupied throughout the remainder of the study. In the 26 days of her occupancy she made a total of 3,983 entries of which 3,310 (83 per cent) were into that hole. The other female (36) established herself in hole No. 5 on day 6 and used it as a residence for the rest of the 28 days even though on days 19, 20, and 23 she was generally inactive and entered the hole less than 10 times. She was somewhat less active than 35 making a grand total of 2,348 entries; 1,943 (82 per cent) of which were into hole number 5. The dominant male occupied several holes. On day 6 he began frequenting No. 4 and deserted it on day 14. His second major hole was No. 19 which he occupied from day 11 through day 28. Twenty per cent of his 4,060 entries was to hole No. 4 and 44 per cent was to hole No. 19. Hole No. 30 was less often visited by him and accounted for only 5 per cent of his total entries. The subordinate male never established a permanent residence. His longest residence was for 3 days (hole No. 8) after which he was displaced by 33 ♂. He was likewise displaced from holes No. 4 and 30. The difference in the males' total number of entries is striking, with 4,060 for 33 ♂ and only 616 for 34 ♂ .

Social Interactions

The following social behaviour were recorded : fighting, chasing, bumping, genital sniffing, mounting, pelvic thrusting, and approaching and following. Chasing differed from following in that the former was slower than the latter. Approaching is defined as an interaction in which one animal comes toward another and in which no other type of interaction (fighting, mating, etc.) results. Bumping is used to describe the striking of one animal with the hip of another. The other terms are self-explanatory. No occasion of what Barnett (1958) called "amicable" behaviour in *R. rattus* were seen in this study.

Categorizing of most of these behaviours into headings such as Aggressive and Sexual is straight forward; Aggressive behaviour involving fighting and bumping and Sexual involving genital sniffing, mounting and pelvic thrusting. Some behaviours, however, are less easily categorized. Chasing, for instance, could conceivably be aggressive or sexual in motivation and it seemed logical to consider all chasing as aggressive except for the questionable case of a male chasing a female. As it turned out, there were no cases of a male chasing a female. Approaching, like chasing, could conceivably be of sexual or non-aggressive motive. However, it seems likely that most of the cases of approaching were aggressive. This will be discussed later.

In this analysis attention is focused on the number and type of interactions initiated (so far as the observers could determine) by the individual rat. The number of interactions initiated by each rat varied a great deal : 33 ♂ initiated a total of 597, while the next most active animal, 35 ♀, initiated only 66. Female 36 was still less active with 20 interactions, and the subordinate male throughout the 28 days of the study was seen initiating only one action, a single approach to 35 ♀.

Figures 3 and 4 summarize the interactions of the 4 animals. Of the 597 interactions of 33 ♂ the majority (81 per cent) were either chasing or approaching the subordinate male. It seems likely that approaching in this case was aggressive, since the timing of the approaches and of the clearly recognisable forms of aggression (fighting, chasing) were almost mutually exclusive (fig. 2). Incidents of clearly recognizable aggression by 33♂ against 34 ♂ tended to occur on a 24 hour cycle, in the morning between 06.00 and 09.00 hours when the subordinate male made most of his trips to the food. This is taken to mean that during most of the "day" 34♂'s trips to food could be intimidated by a mere approach by 33 ♂, but that when hunger drove him to the food platform, more violent forms of aggression resulted (figs. 9, 11).

Relatively little actual fighting occurred. Of the 33 fights recorded 17 were started by 33 ♂, 15 by 35 ♀, and 1 by 36 ♀. Twenty of the 33 fights involved 34 ♂ who, therefore, did somewhat more fighting than any of the other 3 animals. The females chased only the males, not each other, and 36 ♀ bumped 33 ♂ 10 times.

The subordinate male was not seen in any sexual activity. Similar observations were made by Calhoun (1962) on penned Norway rats (*R. norvegicus*) in which some low ranking males showed no sexual behaviour and in which highly dominant males sometimes held territories containing several females.